•1994 Annual Report • Alabama Agricultural Experiment Station • Auburn University•

AAES

ALABAMA
AGRICULTURAL
EXPERIMENT
STATION

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AAES

Alabama Agricultural Research for the 21st Century

The mission of the Alabama Agricultural Experiment Station (AAES) is to conduct research to enhance the economic viability of agriculture, forestry, and related industries; promote environmentally compatible and socially responsible use of Alabama's resources; and improve quality of life for Alabama's citizens. The broad scope of this mission makes it imperative that research priorities be established. Prioritizing AAES efforts requires the analysis of current research and the development of a plan to achieve established goals.

To meet these needs, the Experiment Station established a task force to examine the role, scope, mission, resources, and opportunities of AAES. A faculty advisory committee reviewed task force recommendations and is developing a strategic plan for the AAES. Tables presented on pages 4, 6, 8, 11, 13, 15, 18, 21, 23, and 26 depict an inventory of current research activities, which will aid in strategic planning.

Ten major research priorities emerged from the strategic planning process: Environmental and Water Quality; Animal Systems; Integrated Pest Management; Landscape and Ecosystem Processes; Food Safety, Quality, Nutrition, and Health; Markets and Marketing; Natural Resources; Plant Systems; Processing and Value Added; and Economic and Social Issues. Within each of these program areas, there are numerous research thrusts. There is overlap among the areas, which illustrates the need for an integrated/systems approach to solving the complex problems facing Alabama. This plan will serve as a blueprint to guide current and future research efforts. It is to be a dynamic plan that responds to changing needs, taking into account clientele and faculty input.

Before any rational decision or plan can be developed to address the objectives of the plan, current research efforts in each program area must be assessed. Therefore, the first goal outlined in the strategic plan was to inventory current research, a task that was completed in 1993-94. Approximately 250 AAES projects were categorized into the 10 program areas. We found that almost 100 scientist-years and more than $25 million were devoted to these wide-ranging efforts in 1993-94. Examples of research in these areas, as well as summaries of the overall research effort, are presented in this year's annual report.

This initial step in the strategic plan will allow the AAES in 1995 to take fair, rational steps toward meeting Alabama's needs in the 21st century.

Lowell T. Frobish,
Director of AAES

Environmental & Water Quality

Environmental quality has become an increasingly serious problem as our population has grown and natural resource consumption has increased. Sustained productivity of Alabama's agricultural, forestry, and other natural-resource dependent industries will be limited without immediate and ongoing efforts to maintain quality resources. AAES researchers are confronting a number of major environmental problems facing Alabama: water quality degradation, soil erosion, wildlife habitat destruction, solid waste disposal, non-point source pollution by pesticides or nitrates, and other related threats.

Environmentally sound disposal of animal wastes from poultry and livestock operations is an increasing problem as these industries grow in Alabama. In one of the first studies of its kind, researchers are studying the effects of swine waste lagoon effluent on wetland plants. In one study, researchers studied the effectiveness of examining leaf chlorophyll content as an indicator of wetlands plant inhibition due to increasing ammonia concentration. Poorly growing plants indicate problems with overall wetland health. The study showed some ammonia effects on some plant species as measured by biomass production, but unfortunately it also showed that leaf chlorophyll is not a good indicator of problems caused by ammonia. This use of artificial constructed wetlands was a novel attempt to measure the effect of effluent using a nondestructive, simple, and instantaneous measurement technique.

Several AAES projects seek to develop valuable, environmentally safe uses for the more than two million tons of broiler litter — feathers, excrement, feed, and bedding material — produced each year in Alabama's billion-dollar poultry industry. In one study, horticulture researchers used composted broiler litter as a partial substitute for peat moss in soilless potting media for ornamental plants. Three years of greenhouse studies showed that poinsettias, some perennials, and some annual bedding plants can be successfully grown in a media containing less than 50 percent broiler litter compost. Another phase of the study showed that there is a high degree of consumer acceptance for an indoor potting mix containing litter compost.

Other AAES studies examined the proper agronomic use of poultry litter. In one such experiment, litter-treated peanut plots had higher yields than plots receiving traditional phosphorous and potassium fertilizers. The study demonstrated that broiler litter provides some growth benefits, aside from fer-

Thousands of these Citronelle ponds exist throughout the Lower Coastal Plain, providing much-needed habitats for ducks and other birds. However, few of the wetlands remain unaffected by humankind's activities. AAES researchers are working to protect these vital ecosystems.

tilization, but further research is required to determine the exact nature of these benefits. These experiments demonstrate that poultry litter can be a valuable resource, instead of an environmental burden, if used properly.

Protecting Alabama's landscape requires that researchers first assess existing environmental quality and then develop appropriate means of mitigating potential problems. In one such effort, AAES wildlife specialists are studying shallow, dish-shaped depressions called Citronelle Ponds, thousands of which exist throughout the Lower Coastal Plain. Wood ducks, herons, egrets, and other birds find these ponds to be their only remaining habitat in areas largely converted to row crops or even-aged pine stands. These ponds are among the least known wetlands on the continent. Over 7,000 such depressions have been located over the past three years, 3,000 of which are in Baldwin County. Few Citronelle Ponds remain in anything resembling their original state. Studies of the few remaining relatively undisturbed examples of this habitat may enable researchers to find ways to rehabilitate many of these damaged wetlands.

It is estimated that 10 percent of the nation's water flows through Alabama. AAES researchers are working to protect this valuable resource. Many investigations are aimed at protecting water quality from potentially harmful practices. For example, natural surface water can be polluted by excess nutrients — carbon, nitrogen, and phosphorous — contained in the outflow from fish ponds after rainfall and when ponds are drained to harvest fish. AAES researchers have developed techniques to confront this problem that are comparatively inexpensive, simple, and do not require complicated wastewater treatment facilities. One example of research in this area is the use of constructed artificial wetlands through which pond effluents can pass and be purified by natural processes. Researchers found that an 18-inch-deep wetland about 10-20 percent as big as the pond area can provide excellent treatment of effluent after two to three days, assuming that ponds are managed to reduce effluent volume. Companion research developed methods to improve pond water quality management, feeding practices, pond discharge control, and other strategies to prevent pond effluent from harming surface water quality.

1994 Effort in Environmental and Water Quality Research

Thrust area	Number of scientists	Scientist years	Funding
Protection of drinking water	25	3.60	$ 874,165
Reduction, recycling, reuse, and disposal of wastes	28	4.47	1,378,133
Protection of air, soil, and water	12	0.69	93,213
Safe use and disposal of pesticides	8	0.37	100,001
Impacts of environmental regulations	12	1.20	117,214

In another study of the environmental effects of agriculture, agronomists addressed the concern that machine traffic in turfgrass sod production could affect water and nutrient flow relationships in such a way as to harm the environment. Results of the three-year field study showed no significant effect of traffic on water content or on nitrogen distribution through the soil profile of sod production fields. But the more important finding may be the concentration of nitrogen found in the soil below the growing grass. Nitrate nitrogen in the soil solution was below 10 parts per million at depths greater than 20 centimeters. This means that the applied nitrogen fertilizer is being intercepted and used by developing turfgrass and does not present a serious threat to groundwater.

Pesticide use is an increasing environmental concern, but refined methods of pest control can often alleviate the need for heavy use of agricultural chemicals. When a major peanut disease, tomato-spotted wilt virus, spread to Alabama from Texas, producer response was multiple sprays of insecticide to control thrips, small, winged insects that spread the disease by feeding on seedlings. Unnecessary or excess insecticide use is not only bad for the environment, but it destroys beneficial insects. Entomologists and plant pathologists found that virus transmission occurs so rapidly, thrips can transmit the disease before they die from pesticide exposure. Researchers found that altering planting date and cultivar selection were more effective control measures than pesticide applications. Delaying planting by two to three weeks allows producers to avoid the window of greatest thrip activity and virus infection. The Southern Runner cultivar was found to be most resistant to the virus. So far, tomato-spotted wilt has not reached the epidemic proportions seen in Texas, and the AAES-developed management strategy could prevent it from doing so.

Assessing the social and economic impacts of environmental regulations is another important area of AAES environmental studies. In one project, agricultural economists use a computer model called AGSIM to estimate the economic consequences of farm program, conservation, and pesticide policies. One conservation policy analyzed was the Conservation Reserve Program (CRP), which took 35.4 million acres of land out of production from 1986-92 in the U.S. CRP land will be eligible for return to crop production in 1996, and an estimated 20.3 million acres now in reserve across the nation are expected to come back into use. According to AGSIM, return of this land to production will decrease annual net crop income by about $3 billion, increase livestock annual net income about $1 billion, and save U.S. consumers about $4 billion a year. Taxpayer expense for crop deficiency payments will increase by about $1 billion in 1996 and about $300 million by 2008.

Economic & Social Issues

Alabama's most important resource is the people who drive the state's economy and society. Despite the great potential of this human resource, there still remain many economic and social issues that must be addressed for Alabama to advance. Problems related to education, poverty, rural property, environmental awareness, health care, community and economic development, individual and family well-being, and urban and rural aesthetics are high priorities in AAES research.

Vitality of small town life depends largely on the vitality of rural retailing, and understanding rural economic conditions is essential. Consumer affairs researchers studied six sites in Alabama, each representative of a specific economic environment. At each site, researchers examined three sets of factors that affect rural retailing — environmental factors, merchant practices, and consumer behavior — with the objective of understanding interactions among the factors. Researchers identified five retail mix options at the sites: office park, rural services hub, specialty service center, recreational focus, and shopping-as-entertainment. Consumers were surveyed to determine how they viewed local stores, compared to shopping alternatives; what was the preferred mix of retail stores at each site; and what were the most valued attributes of "anchor stores" (highly preferred outlets). Survey findings varied from site to site. A survey of business practices revealed little variation among the sites. Researchers are now interpreting the data to determine how this information can be used in an often-overlooked area of rural economic development: retail stores in a town's central business district.

Rural property use and environmental awareness are important issues in maintaining the

Children are Alabama's most precious natural resource. Many AAES studies focus on improving the health and well-being of tomorrow's leaders.

1994 Effort in Economic and Social Issues Research

Thrust area	Number of scientists	Scientist years	Funding
Economic and community development	4	0.28	$ 60,020
Environmental awareness	9	0.64	68,207
Individual and family well-being	12	3.44	354,368
Urban and rural aesthetics	10	1.06	96,035
Pest and disease management	14	1.06	201,874

sustainability of Alabama's resources. In a study related to these issues, AAES forestry researchers examined the environmental attitudes and practices of nonindustrial private forest (NIPF) owners. Forest regeneration, waterway protection, and other measures of site condition were determined by field inspection at recently clear-cut NIPF tracts in west-central Alabama. Owners who were satisfied with a timber harvest were more inclined to regenerate harvested stands. Most owners appeared knowledgeable about the status of their forests and had taken steps to regenerate the land. In contrast, few owners recognized the need for best management practices (BMPs) to protect adjacent waterways, and fewer still had implemented adequate BMPs. Despite this lack of action to protect water quality, surveys revealed that Southern NIPF owners share the general public's strong environmental concerns.

A study by AAES family and child development researchers indicated that Alabama could soon face a crisis in the delivery of pre- and postnatal medical care in rural areas. Thirty of 67 counties were found to be without the services of obstetricians and pediatricians. Results further indicated that while many of the state's obstetricians and pediatricians considered discontinuing their services, the closing practices were offset by the opening of new practices. However, the vast of majority of new practices were to be opened in more urban areas. In a survey of obstetric and pediatric patients, more than 25 percent said they would not be able to find health care of equal quality if their physicians left the area. The distance traveled to receive these services is greater for rural residents, and if further services are lost, many may find it difficult to replace them.

Healthy ornamental plants are important in enhancing the aesthetics of urban and rural areas. In landscape settings, disease resistance is an efficient, cost-effective, and environmentally friendly tool in managing diseases of woody ornamentals. Horticulture researchers are screening crabapple, dogwood, indian hawthorn, and crapemyrtle for their reaction to common diseases. In 1993-94 fireblight was the predominant disease in crabapple, but of 60 crabapple cultivars studied, only Coral Burst and Jacki exhibited no symptoms. In a severe outbreak of powdery mildew in 1994, only two of 25 flowering dogwood selections were free of disease — Cherokee Brave and Dwarf White. Few or no symptoms of Entosporium leaf spot were seen on 15 of 21 indian hawthorn cultivars. Of 45 crapemyrtle cultivars, 17 were free of powdery mildew symptoms.

Plant **Systems**

AAES efforts to develop new crop varieties and to improve management and cultural practices for existing crops will have a major impact on Alabama's economy.

To remain competitive with other states and countries, Alabama agriculture must adapt new technology and pursue new markets to increase the profitability of plant production systems. Forest products, agronomic row crops, horticultural and specialty crops, and forages for livestock production are the mainstay of the plant-based portion of Alabama's economy. Through plant breeding, development of new production technology, design of improved management practices, and basic studies of plant growth, reproduction, and health, AAES researchers strive to make the state's plant-related industries even stronger.

In 1993, eight Alabama nurseries grew approximately 10 percent of the entire U.S. tree seedling crop. Many of these seedlings were grown using management strategies developed in AAES research. For example, most managers keep their seedbeds relatively weed free by using herbicide prescriptions developed in the forest nursery program. Over the past decade, Alabama nurseries have saved more than $1 million in weed control costs by using these herbicide management regimes. Recent research has helped distinguish important seedling attributes. Researchers found that large seedlings compete better with weeds than regular-size "nursery-run" seedlings. Data suggest that spending a few more dollars on high-quality seedlings is more beneficial than applying herbicides to help regular seedlings compete against weeds. In some cases, use of water soluble herbicides in pine plantations could be avoided by planting seedlings better able to compete against weeds.

For more than a century, AAES researchers have conducted soil fertility studies to meet the needs of Alabama crop producers. In recent research, agronomists determined the calcium requirement for peanuts, but also found that a high concentration of this nutrient helps control a major food safety problem associated with the crop. Experiments were conducted to learn the effect of soil calcium concentration on *Aspergillus flavus* infection and aflatoxin concentration in peanuts. *A. flavus* is a type of fungus that produces aflatoxin. As concentrations of seed calcium and soil calcium increased, incidence of the fungus decreased. Germination percentages decreased with decreasing seed and soil calcium concentrations, as well. The ability to determine potential germination based on seed analysis gives farmers another tool in deciding the suitability of the crop to be sold as seed or as a food product.

For many decades Southeastern farmers relied on legumes in crop rotations to improve soil fertility, but the availability of inexpensive chemical fertilizers contributed to a decline in their use. In recent years, there is renewed interest in using legumes to boost production, reduce costs, and protect the environment. AAES researchers, in cooperation with the Soil Conservation Service Plant Materials Center, have released two new legume cultivars — AU

1994 Effort in Plant Systems Research

Thrust area	Number of scientists	Scientist years	Funding
Plant breeding	12	1.88	$ 979,275
Mechanisms of plant growth and reproduction	22	3.53	1,101.945
Plant health and production	28	5.02	1,187,538
Best management practices	33	4.91	1,599,679
Plant/soil interactions	22	1.85	472,282
New production technologies	17	3.18	746,364
New markets for plant products	1	0.12	8,826

GroundCover, a caley pea; and AU EarlyCover, an early-flowering hairy vetch — that are well adapted to Alabama. In addition to their role in increasing soil fertility, GroundCover and EarlyCover are valuable as high-protein forage crops and as winter cover crops to reduce soil erosion. Both varieties will be available for the 1995 fall planting season.

Progress also has been made in overcoming constraints to producing and using varieties of winter-type, sweet white lupin as an alternative winter cover crop. Research conducted from 1989-94 concentrated on identifying problems and management practices for successful lupin cultivation. Tests showed that lupin has promise as a green manure, silage, and grain crop for the Southeast. Alabama is a grain-deficit state, so lupins could prove to be a valuable new livestock feed source. Farmers also could benefit by having a new winter cover crop that enriches the soil with little producer input. Cultivar choice and seeding date were found to be primary production variables for maximum yield. Top grain yields exceeded 3,900 pounds per acre. Novel alternative double-cropping systems using lupin with grain sorghum or with a new hybrid grain-type pearl millet show great promise. Future research will include refinement of production practices, long-term rotations, breeding of adapted cultivars, disease and pest management, animal utilization, and opening market channels.

AAES plant systems research also has a strong impact on fruit production. For example, horticulture researchers have developed better methods for producing high-density apple orchards that can produce early and sustained yields of quality fruit with a reduction of management input requirements. Researchers grafted various combinations of four dwarf and three semidwarf types of apple trees to produce Red and Golden Delicious apples. The largest per-acre yields were produced when a six-inch interstem of the dwarf variety EM26 was grafted onto rootstock of the semidwarf variety MM106. This combination of varieties produced 30 percent more fruit than the semidwarf rootstock MM106 alone and 22 percent more than the dwarf EM26 alone. This hybrid apple tree also is smaller than the dwarf varieties, an advantage that allows the trees to be har-

About 65 percent of Alabama's land surface is covered in forest, forming the basis for an industry valued at more than $1 billion. As forest production shifts away from the Pacific Northwest, this industry is expected to grow even larger throughout the Southeast. Sustained, economical use of the state's forest resources is a major goal of the AAES.

vested without ladders and alleviates the expense of trellising and annual pruning.

In other fruit-related research, studies continued on a type of bee that AAES entomologists proved to be a requisite pollinator of rabbiteye blueberries in Alabama. Without the Southeastern blueberry bee, many commercial growers and home owners would produce few, if any, blueberries. In good weather, researchers estimated that the lifetime foraging activity of each female blueberry bee produces five gallons of blueberries worth $60 at mid-season prices. This has been the first study in the Southeast to show the importance of native, solitary-nesting bees to regional agriculture and only one of a few to compare pollination efficiencies of native bees with managed honey bees on crops requiring bees for pollination. Honey bees proved to be ineffective pollinators of rabbiteye blueberries. Studies continue on the blueberry bee's basic biology, management potential, alternate nectar hosts when rabbiteye is still in bud, and geographical distribution.

Studies to support Alabama's ornamental horticulture industry represent another major area of AAES plant systems research. In one ongoing investigation, researchers are evaluating chemicals that reduce labor expenses in nursery crop production, while enhancing product quality and marketability. Chemical plant growth regulators reduce the need for pruning ornamental plants by promoting compactness or increased branching, both of which enhance plant quality. Researchers have evaluated the use of about 12 chemicals on bedding plants, pot crops, herbaceous/woody ornamentals, and foliage plants. The chemicals inhibit growth, control sprouting, promote flower development and growth, or increase branching. The studies have yielded results on the best application rates and methods, as well as describing the positive and negative effects of the chemicals.

Processing & Value Added

Value added may be defined as any activity which increases the value or usefulness of raw food and fiber materials or partially processed products. Farming and forestry are at the base of the food and fiber value-added sector. Finding new and better uses for Alabama's raw food and timber products is the goal of many AAES researchers, whose efforts could multiply the value of many of the state's natural resources.

Agricultural engineers are involved in several projects that are making Alabama's forest products more valuable and more environmentally friendly. Efforts to develop timber bridge systems are opening new markets for the state's Southern pine lumber and manufactured composite wood products, while lessening the environmental impact of forest harvesting activities. Researchers have designed two types of portable timber bridges to be used as temporary stream-crossing structures. The bridges, which are made of glued-laminated (glulam) timber beams, have performed successfully under log truck and forestry equipment traffic. Because the bridges can be installed and removed with a minimal amount of site disturbance, they are an environmentally friendly option for temporary stream crossings. Finally, their ability to be reused many times makes them a cost-effective alternative to the traditional fords and culverts. Although the primary application of these portable bridges is on forest roads and skid trails, they can also be used in highway construction where a bridge is being replaced or where a bridge has been washed out by flooding.

Sawlog quantity and quality is slowly declining as numbers of large trees decrease. Forestry researchers are addressing this problem, while also finding valuable uses for low-grade hardwoods. The larger and longer members needed for floor and roof framing are becoming less available and more expensive. Using low-grade hardwood trees once considered only a nuisance in the forest industry, AAES researchers developed and are testing composite structural I-beams. The I-beams, which use finger-jointed sections of solid wood or laminated veneer lumber connected by thinner panels of compressed wood flakes, are lighter and possibly stronger than conventional solid beams. Current studies are designed to col-

Portable timber bridge systems not only provide valuable new uses for Alabama's forest products, they lessen the impact of forest harvesting activities.

lect information needed to improve I-beam design and to better understand long-term I-beam performance and structural reliability under changing environments. Auburn is recognized as the leading institution for wood composite I-beam research.

1994 Effort in Processing and Value-Added Research

Thrust area	Number of scientists	Scientist years	Funding
Status of the value-added sector	2	0.11	$ 21,120
Operational and technical efficiency of the value-added sector	6	1.45	296,980
Product quality and market feasibility	11	1.62	400,948
Human resources in the value-added sectors	1	0.06	18,189

In the area of value-added food products, research continued in 1994 on AU Lean low-fat ground beef and fresh pork sausage patties. Recent studies concentrated on the storage stability of AU Lean products. Low-fat ground beef patties were formulated to contain lactate, in addition to the food additive carrageenan that gives AU Lean its sensory properties. Carrageenan-based patties were more juicy and tender and higher in beef flavor intensity, as compared to low-fat all-beef patties with no additives. Bacterial growth in the AU Lean patties was reduced through the use of lactate with no deleterious effects on the sensory properties of the product. The objective of another study was to evaluate lower value beef cuts for the manufacture of low-fat ground beef. After 24 weeks of frozen storage, AU Lean patties using the alterative lean raw materials had equal or improved eating quality compared to commercially manufactured 20 percent fat all-beef patties.

In other food technology research, poultry scientists found that altering the diets of commercial broilers can extend the shelf life of poultry products. By using a diet high in the monounsaturated fatty acid oleic acid as contributed by a genetically modified fat in corn, researchers were able to decrease the growth of the natural bacteria that cause the taste and odor problems associated with spoilage. Researchers also found that this alteration in carcass fat has an additive effect with packaging. When wrapped in a "gas-impermeable film" that restricts the flow of oxygen, shelf life of poultry meat could be extended even further.

Markets & Marketing

Markets for Alabama commodities require careful study if the state is to benefit from changes in the many forces that shape national and international markets. Information is required on trade laws, governmental policies, new technology, consumer preferences, comparative advantage, and other factors. Research also is needed to strengthen established markets and identify new markets for Alabama commodities. AAES scientists are addressing these issues as they relate to the state's diverse agricultural, forestry, and manufacturing products.

AAES agricultural economists are performing a series of studies to determine the effects of generic advertising of cotton, catfish, and dairy products. One study focuses on a promotional program that the cotton industry conducts to encourage foreign countries to use more U.S.-produced cotton in their spinning and weaving industries. Research found that the major beneficiary of this program is the American taxpayer. According to the study, a $10 million increase in foreign promotions would reduce cotton deficiency payments by $66 million.

In the area of defining new markets for Alabama products, AAES consumer affairs researchers are studying Mexican buyer behavior and consumer preferences for apparel. Mexico already is a major importer of Alabama apparel products, and as that country's $20 billion apparel market is expected to increase about 15 percent a year, continued export growth is promising. In a preliminary study, Mexican retail buyers rated quality as the most important clothing attribute, followed closely by style and price. Although price is important to Mexican buyers, they often buy the higher priced merchandise because it is less expensive in the U.S. than comparable quality elsewhere. Image and brand name are extremely important to Mexican consumers, who are willing to spend a larger amount of their income on high-quality apparel than their U.S. counterparts.

Another major AAES research focus concerns the effects of government policies on production and marketing of products. In one study, economists examined the best strategy for minimizing the risk of farming. Researchers found that a North Alabama corn producer can best minimize risk by Farm Program participation, combined with the yield protection offered by Multiple Peril Crop Insurance. Also, farmers who have the necessary production volume and can afford it should consider protecting themselves against price drops by participating in the commodity futures market. In short,

Textile and apparel manufacturing is one of Alabama's leading industries. Developing new markets for these products is a significant part of the AAES mission.

1994 Effort in Markets and Marketing Research

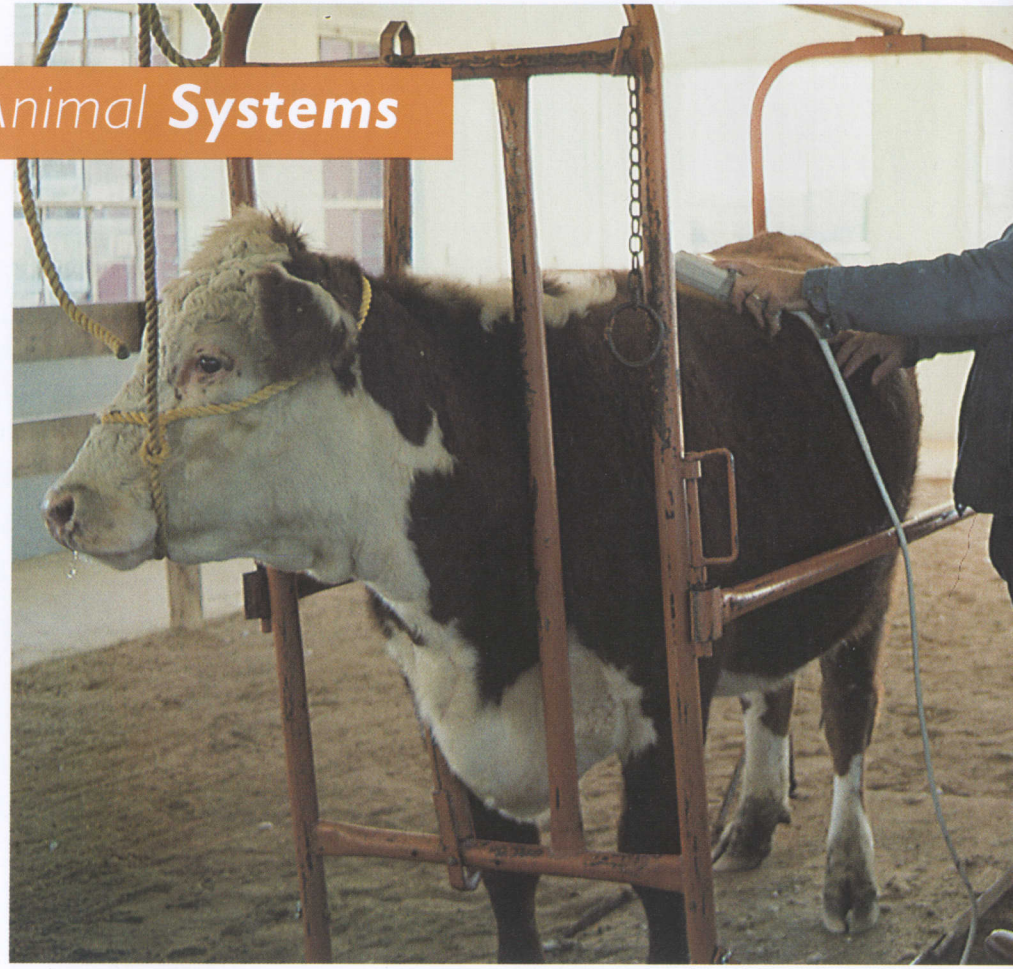
Thrust area	Number of scientists	Scientist years	Funding
Retail market strategies	12	1.76	$166,925
Advantage of Alabama products	9	0.70	51,042
Institutional programs and markets	8	0.76	48,465
Effects of government policies	12	1.50	154,455
Potential of new products	9	0.94	151,567
Forecasting consumer demand	10	0.74	149,336
Generic advertising and merchandising	6	0.99	151,137

there is much crop producers can do to protect themselves against losses, but active participation in planning and marketing is required.

Economists have developed a programming model that can be used to quickly evaluate national policy issues affecting the beef industry in Alabama and the U.S. One study found that promotion and adoption of low-fat ground beef products by the industry could lead to more production of forage-based slaughter cattle in the South. Researchers found that there may be significant growth potential for the Southern beef industry, given timely and effective investment to promote adoption of low-fat ground beef technology and products. Another study found that an efficient slaughter facility is a key factor in increasing finished cattle production in Alabama.

Other economists are using computer analysis to determine the effects of the Boll Weevil Eradication Program, which is jointly funded by USDA and cotton producers. Researchers found that program increased cotton yields by approximately 100 pounds per acre in South Alabama, where the program has been in effect since 1987. These increased yields were significant enough to induce farmers to shift a great deal more acreage from wheat and soybeans into cotton. Research also showed that under the 1990 Farm Bill, producers face little financial risk in expanding cotton production. Results indicate that the private costs are completely covered through program benefits.

Animal **Systems**



Animal systems research has tremendous potential for positive impact on agriculture in Alabama. Improvements in production efficiency, management practices, animal health, and other areas are crucial to the continued growth of the state's poultry, beef, dairy, swine, and aquaculture industries. Current AAES animal systems research ranges from basic studies to reveal essential life-supporting mechanisms to efforts to develop applied technology to increase the efficiency of nutrient production from animal sources.

In one recent study, AAES animal scientists developed methods for using ultrasound to determine a bull's genetic quality at an early age. The traditional method of determining the genetic merit of sires and dams is to slaughter the animals' offspring and measure the carcass traits. However, this means that a bull will be at least 39 months old before its first progeny are tested, a factor that does not facilitate rapid genetic progress. Real-time ultrasound technology, on the other hand, is a nondestructive means of quantifying ribeye area and backfat thickness in live animals. Researchers showed that ultrasound can be used to accurately measure these characteristics in yearling breeding stock, a finding that may eliminate the need for extensive and expensive progeny testing.

Other animal scientists are seeking alternative methods of increasing the production of lean meat through nutritional regulation of gene expression in beef cattle. Researchers concluded that dietary protein affects the expression of the gene that controls production of "insulin-like growth factor-I" (IGF-I), a hormone that controls skeletal development and muscle protein development during growth. Furthermore, they showed that feeding excess protein increased growth, but it was due to fat deposition and not muscling or altered IGF-I gene expression. Although this type of production system is desirable under the current USDA grading system, it would not be economically profitable in a value-based marketing system wherein a producer is rewarded for the production of lean beef.

Animal scientists have developed techniques for using ultrasound to determine a yearling bull's potential for producing high-quality offspring.

1994 Effort in Animal Systems Research

Thrust area	Number of scientists	Scientist years	Funding
Growth, development, and reproduction	34	7.29	$3,549,611
Animal performance and health	36	6.54	1,798,310
Environmental conditions and management practices	37	5.94	1,853,805
Integrated systems to produce high-quality, socially acceptable food	7	0.25	98,280

Animal scientists also made an initial step toward improving nutritional management of the cow/calf herd. All cow/calf operations depend on forage as the main source of nutrients, but Alabama's forage base is of low quality from August through weaning time in October. Supplementation with molasses-based products during this period was shown to be the most effective feeding strategy for improving both cow and calf performance. Unfortunately, the cost of molasses supplementation outweighs the improved weight gains. Future research will seek to control molasses consumption by limiting its access to calves only.

Studies by animal health researchers may help minimize the effects of disease on calf losses or body weight losses, thus enhancing livestock performance. In one study, researchers found that growth hormone secretion is inhibited by cortisol, a hormone released in response to stress and disease. Although cortisol is a normal portion of an animal's response to disease, long-term exposure inhibits growth. In another study, calves pretreated with an estrogen-progesterone growth implant were significantly protected against the effects of subsequent infection with coccidiosis; the calves had fewer days of fever, less severe diarrhea, and lost less weight.

Alabama produces nearly one billion broilers annually with a gross value of about $1.5 billion. AAES poultry scientists have developed guidelines to help producers conserve energy in broiler production. For instance, researchers found that gas used in heating can be reduced an average of 20.5 percent by using double layers of plastic curtains, as compared to single curtains, on poultry house sidewalls. Another study indicated that using ceiling fans in poultry houses reduces total energy needs by about 8.3 percent. Ventilation is needed in poultry houses to remove moisture, but it also removes heated air. Gas savings of approximately 19 percent were realized when ventilation was controlled by a microprocessor system to remove 50-60 percent of the moisture at a high rate during the warmest seven to nine hours of

Alabama is the second leading channel catfish producer in the U.S. with an annual harvest valued at about $50 million. This industry has the potential to grow even larger thanks to AAES research.

the day, with remaining moisture removed by ventilating at a lower rate during the other 15-17 hours.

Alabama is the second leading channel catfish producer in the U.S. with an annual harvest valued at about $50 million. Most catfish are raised in shallow, flat-bottom ponds that are easily seined to harvest fish. However, fish farming is restricted in watershed ponds, which are deep and have irregular bottoms and sides, requiring pond drainage to remove fish. This process is more difficult and nutrient-laden drainage can harm the environment. AAES fisheries researchers investigated methods to raise catfish in impounded water, including alternative harvesting methods. Two alternatives involve raising catfish in floating enclosures, either cages or in-pond raceways that allow the collection and removal of solid wastes. These high-density culture systems can cause problems related to fish overcrowding but permit easy harvest without draining ponds and releasing nutrient-rich effluent. Researchers discovered the factors required to maximize the usefulness of these systems while minimizing their potential drawbacks. The cage method proved almost equal to growing catfish in ponds in terms of fish survival, feed conversion, and harvest weight; fish survival was lower in the raceway system, but other factors were similar. Best production was from selected strains of Kansas, Marion, and Auburn channel catfish.

Sport fishing also plays a vital role in Alabama's economy. With expenditures exceeding $600 million a year, sport fishing ranks third in the state in terms of dollars generated in natural-resource-related activities. However, other recreational activities often conflict with fishing on the state's lakes and reservoirs. Lake managers are faced with the dilemma of providing for multiple uses. For example, high levels of aquatic plants hinder boating and swimming, but bass anglers generally prefer to fish areas that have plants. Fisheries researchers compared eight years of fishing tournament data to levels of aquatic plant coverage in reservoirs on the Tennessee River. Anglers tended to catch more fish when plants were more abundant, but these fish were smaller compared to periods when plant levels were lower. In another study, researchers found that vegetated bays and protected coves contained greater numbers of young bass than vegetated areas in the open portion of the reservoir. Thus, lake managers could control plant growth in these mid-reservoir regions without sacrificing bass nursery areas. Fisheries experts also discovered that bass reproduction was lessened throughout the reservoir when rainfall amounts were high and the reservoir flushed very quickly during the spring spawning and rearing season.

Renewable **Natural Resources**

Shrimp from the Gulf of Mexico is one of Alabama's many renewable natural resources. Auburn marine fisheries researchers are refining a method for predicting commercial brown shrimp harvests.

Alabama has an abundance of high-quality, diverse, and valuable natural resources that sustain numerous industries, support wildlife habitat, provide recreation, and generally ensure the health and well-being of the state's population. However, steps must be taken to allow sustained use of these resources, to manage and promote biological diversity, and to protect the quality of water and other resources. AAES researchers are leading efforts to ensure sustainable use of Alabama's water, forests, wildlife, plants, soil, and other resources.

AAES fisheries experts are developing techniques for rapidly assessing stream health. The system is based on locating healthy streams in each ecological region of the state. Fish and aquatic invertebrates are collected from a relatively undisturbed stream, counted, and identified to create a biological index, or "bioindex." Using the bioindex, a reference stream can be compared to other streams in the same region to identify polluted waterways. Despite the difficulty of finding relatively undisturbed streams, researchers have identified at least one reference stream in most ecological regions of the state. Further investigations are underway to learn more about the biological communities of these relatively healthy systems. Bioindices indicate that Alabama's streams are most often polluted by excess quantities of nitrates and phosphates and by accumulation of excess silt and sand from erosion.

In a review of U.S. water law, AAES forestry and agricultural economists concluded that Alabama has a unique opportunity to implement comprehensive water markets, which would lead to more efficient use of water. Alabama is not now burdened with complex legislation regulating water allocation. It is probably the only state still relying on the basic riparian system, which allows use of water to those adjacent to waterways. In most states, extensive legislation defines one's rights to use and transfer water rights for a fee. Alabama, on the other hand, is in the position of being able to organize and define a new market system with-

1994 Effort in Natural Resources Research

Thrust area	Number of scientists	Scientist years	Funding
Impact of sustained natural resource use	33	2.25	$840,921
Management and promotion of biodiversity	17	1.64	230,929
Political issues and regulations affecting sustainability	7	0.35	27,375
Use of Alabama's natural resources	32	4.45	570,510
Water resources	16	2.36	272,671
Management of natural resource systems	32	4.28	752,268

out becoming entangled in complex existing water institutions.

Seafood from the Gulf of Mexico is another of Alabama's vital natural resources. Shrimp are the basis for the state's most valuable commercial fishery. However, commercial brown shrimp harvests have fluctuated greatly over the past 30 years. In an AAES project, marine fisheries researchers used 19 years of environmental data to develop a model to predict annual abundance of shrimp. The model was 87 percent accurate in predicting harvests in 1992; 81 percent in 1993. Mobile River discharge, water temperature, and other factors were compared to shrimp harvests for 1975-93. High river discharges were correlated with low catches, while low discharges were correlated with high catches. Environmental conditions in the shallow bays and marshes that serve as nursery areas for shrimp have a major effect on the number of shrimp available for harvest. High river discharge dilutes the salt content of these areas, and low salinity is not conducive to young shrimp survival. Wind direction and velocity also affected shrimp production, but the reason why is not clear. Future research will examine how wind might affect production.

Developing management strategies for economically important wildlife is a major thrust in AAES natural resources research. In one such study, wildlife scientists are examining the many unexplored aspects of wood duck biology to provide information for better management of the birds. Wood ducks, the most abundant species of duck breeding in Alabama, inhabit wetlands throughout the year. In one recent study, researchers found that the reproductive period is as strenuous for male ducks as it is for females. Females spend days feeding in preparation for producing and incubating a clutch of eggs. Throughout the process, males play an important role in breeding success by guarding the female ducks and watching for predators. Researchers found that the amount of fat reserves used by breeding males was similar to that reported for females during egg production. Since the breeding season is an energy-demanding time for both sexes, wetlands must provide adequate foods early in the breeding season so birds can store the nutrients needed for successful reproduction.

The white-tailed deer is the most important game species in North America; it is the basis for a $600 million hunting industry in Alabama alone. A multifaceted AAES research program addresses questions that are important to the proper management of this valuable resource. In one study, researchers found that vitamin and mineral supplements fed to captive deer produced no effect in terms of body size,

The white-tailed deer is the basis for a $600 million hunting industry, making it one of the state's most valuable natural resources. The AAES sponsors a wide-ranging research program to improve management of this economically important species.

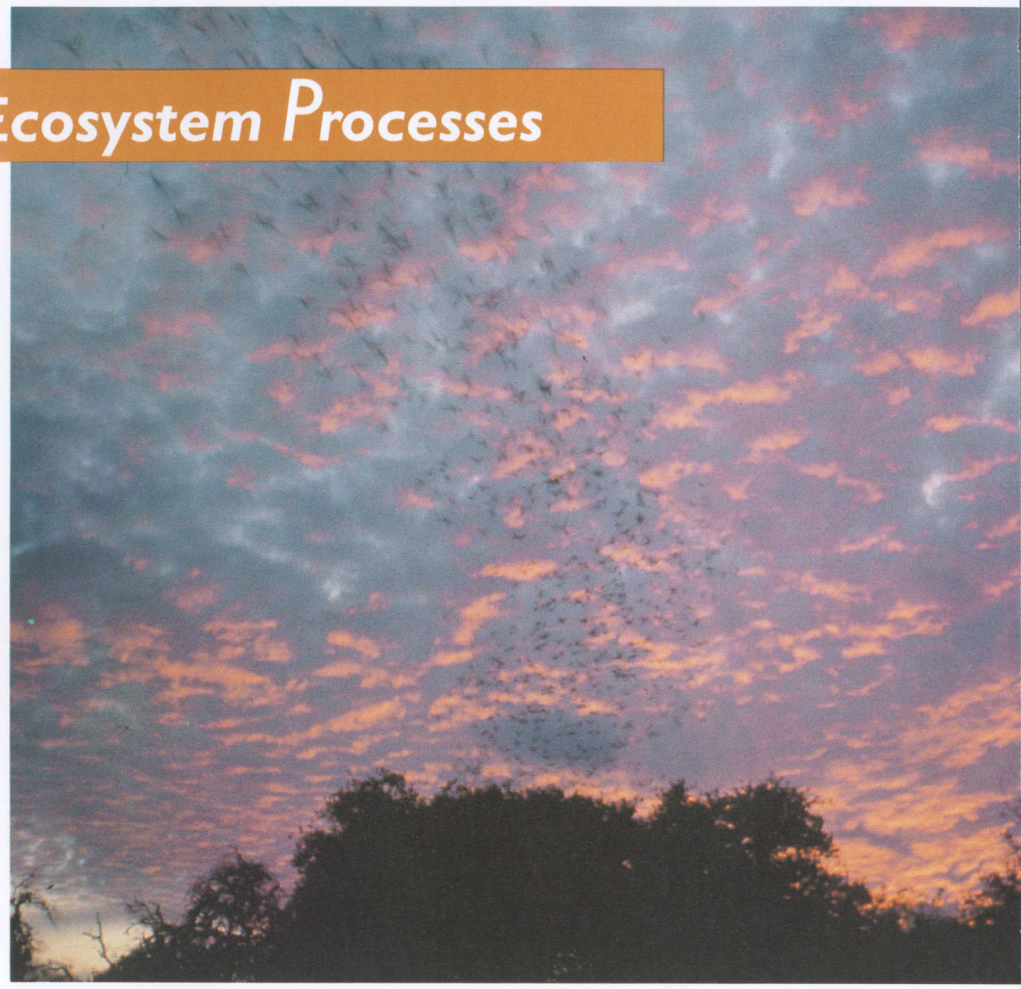
antler size, antler width, or number of antler points. Previous research showed that dietary protein was much more important in deer growth and antler development. Another study showed that white-tailed fawns weaned as early as 60 days survived and grew at rates not significantly different from fawns that remained with their dams.

Timber is one of Alabama's most important natural resources. In the management of timber stands, thinning provides an opportunity to improve overall stand growth and use wood that would be lost to natural mortality. However, it is important to avoid damaging roots by rutting or scarring trunks with machinery. In efforts to improve thinning of Southern forests, researchers found that forwarder systems have much less impact on timber stands than skidder systems. In forwarder systems, trees are felled and processed in the stump area. Limbs and tops are spread around the stand, putting nutrients back in the soil. Forwarders support payloads completely off the ground, reducing ground disturbance. Plus, they carry about 10 times as much wood as a skidder and thus make fewer trips in the woods.

A pine stand must be tended much as a home garden or agronomic crop to insure optimum production. Just as a gardener controls weeds, a forester must control unwanted forest vegetation. Forestry researchers have determined that grasses and weeds are best controlled in the spring immediately after planting pine seedlings. Studies show that a single herbicide application can reduce the time it takes to grow a marketable stand by up to six years. Control of unwanted hardwood stems is best done before pine seedlings are planted.

Other forestry researchers have found that a significant amount of lumber from certain Southern pine plantations may not meet required standards for strength and stiffness. Researchers examined the effects of stand age on the properties of lumber obtained from 25- to 35-year-old plantation-grown loblolly pines with an initial spacing of 8x8 feet. Results suggest that much of the lumber produced from relatively young plantations does not meet required standards. Although these qualities improved with tree age, only 89 percent of lumber from 35-year-old trees met strength requirements; 52 percent met stiffness requirements. These results can serve as guidelines to forest managers to manage pine plantations for lumber and avoid product liabilities.

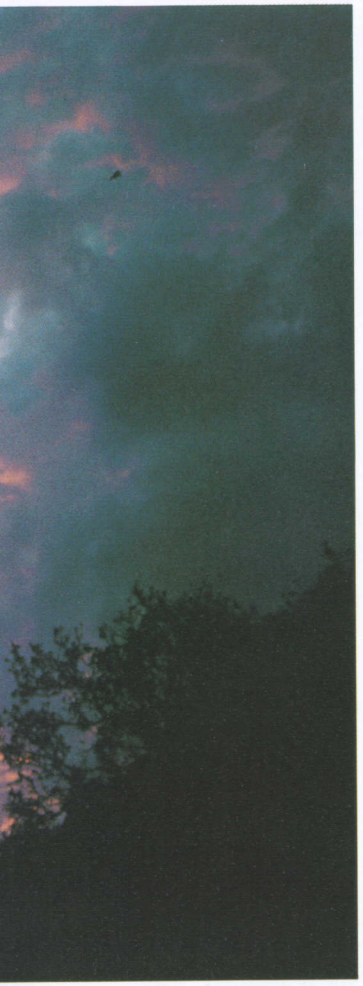
Landscape & Ecosystem Processes



Alabama's landscape contributes significantly to our nation's production of plant fibers, wood products, and food. In addition, many rare and endangered species live in this region. Studies of biological diversity, stability of plant and animal populations, species interactions, and ecosystem structure and function are needed to define and sustain healthy biological systems in the state. AAES researchers are working to inventory Alabama's flora and fauna, determine and quantify stress factors that affect ecosystems, and study how global change affects the local landscape.

Alabama is home to 16 species of bats, some of which are endangered. There are several long-term advantages to learning more about the ecology of bats. Bats are amazingly efficient at controlling night-flying insects, such as mosquitoes and other agricultural pests. The endangered gray bat occurs in habitats along waterways adjacent to cotton fields in North Alabama. These bats can be vulnerable to chemical pesticides used to control insects. Several gray bat colonies are located near impoundments of the Tennessee River in a region participating in the USDA Boll Weevil Eradication Program. Using radio transmitters, AAES zoologists set out to determine if the bats' flight paths from Indian Cave in Limestone County and Blowing Spring Cave in Lauderdale County to Wheeler Reservoir placed them in danger of exposure to insecticides used against boll weevils. Researchers found that gray bats in this area spend most of their time foraging over open water and little, if any, time over land where they might come into contact with the pesticides.

Forests cover more than two-thirds of Alabama and are an essential part of the state's ecological, economical, and social fabric. Forest regeneration after harvesting is the key to sustainable forestry. Auburn University is a leader in "artificial regeneration," which involves preparing harvested sites, growing seedlings in special nurseries, planting seedlings, and cultural treatments for the first three years after planting. Current research in this area focuses on the environmental effects of artificial forest re-



Thousands of bats stream across Alabama's skies each night, playing a vital role in insect control. AAES scientists are gathering information to help save the endangered gray bat from extinction.

generation systems. One important finding was that key pesticides commonly used in seedling nurseries do not move through the soil and therefore do not pose a risk to groundwater. Related work showed the effectiveness of drainage ditches and border areas in nurseries to uptake and transform excess nitrogen fertilizer. A large-scale study was recently initiated to examine how water quality in small streams is affected by timber harvesting followed by intensive site preparation.

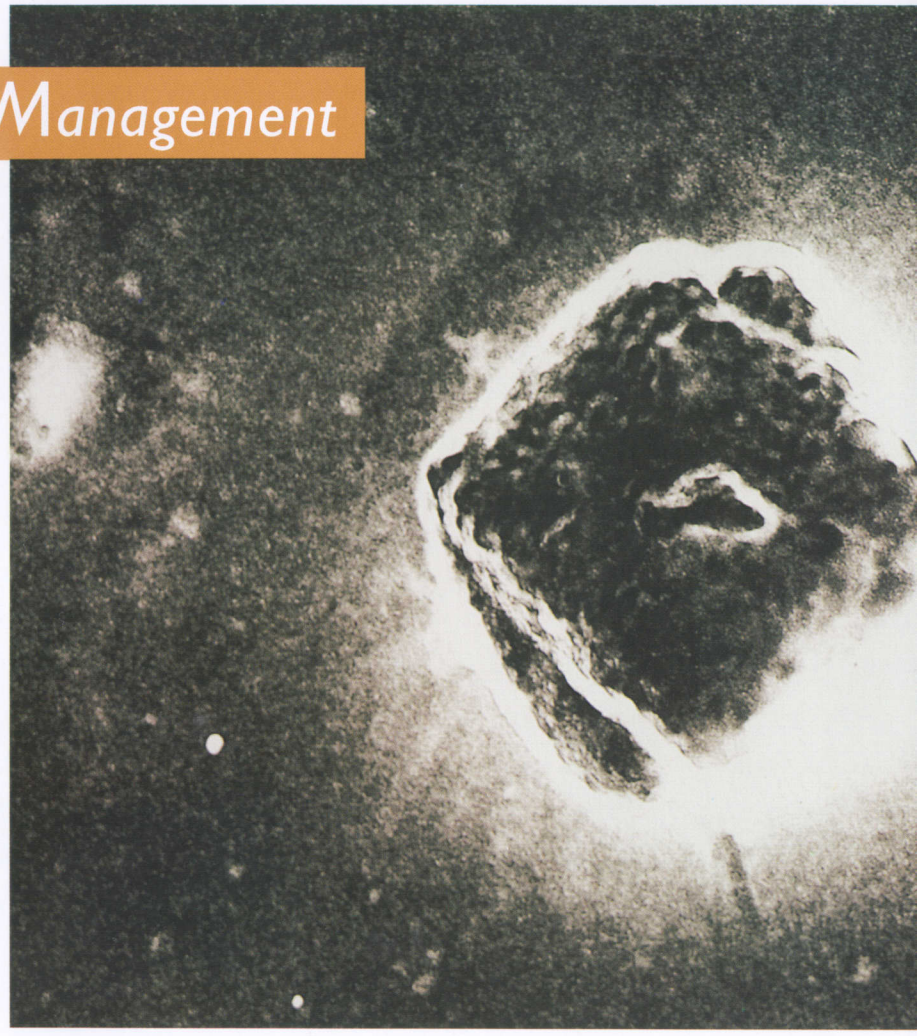
Alabama's vast forest resources could be threatened by air pollution, even in areas believed to be pristine. Field surveys by forestry researchers show that visible symptoms of ozone injury can be found on several tree and shrub species in several national forests in Alabama. Ozone is created when hydrocarbons and nitrogen oxides from manufacturing and automobile exhausts react in the atmosphere. Of the three national forests surveyed so far, the most injury has been found in the Talladega National Forest near Birmingham. Although symptoms have been detected in the field, there is currently no evidence to indicate that ozone is affecting the productivity of these forests. A related study is underway using open-top chambers (outdoor greenhouses) to determine if ozone can affect the diversity and productivity of natural forest communities. Preliminary results suggest that ozone may reduce species diversity.

1994 Effort in Landscape and Ecosystem Processes Research

Thrust area	Number of scientists	Scientist years	Funding
Role of biological diversity in ecology	13	1.20	$225,975
Sustainability of ecological systems	16	1.06	173,242
Effects of global change on local ecosystems	6	0.82	134,427

Important species interactions occur at all levels, above and below the soil. Most woody plants establish a symbiotic relationship with specialized, beneficial root-colonizing soil fungi, which extend the plants' ability to absorb nutrients and water or perform other vital functions. AAES microbiologists have developed methods of genetically engineering a mushroom-forming fungus associated with pine root systems. This discovery will allow researchers to improve the symbiotic benefits by introducing new genes from a variety of sources into the fungus. Candidates for such studies are genes that improve the plant's ability to absorb nutrients, help fight off pests that feed on roots, or confer tolerance to dehydration or to high salt content of soils. Successful genetic engineering of the fungi could provide an alternative to more expensive and environmentally unfriendly chemical methods for controlling root disease.

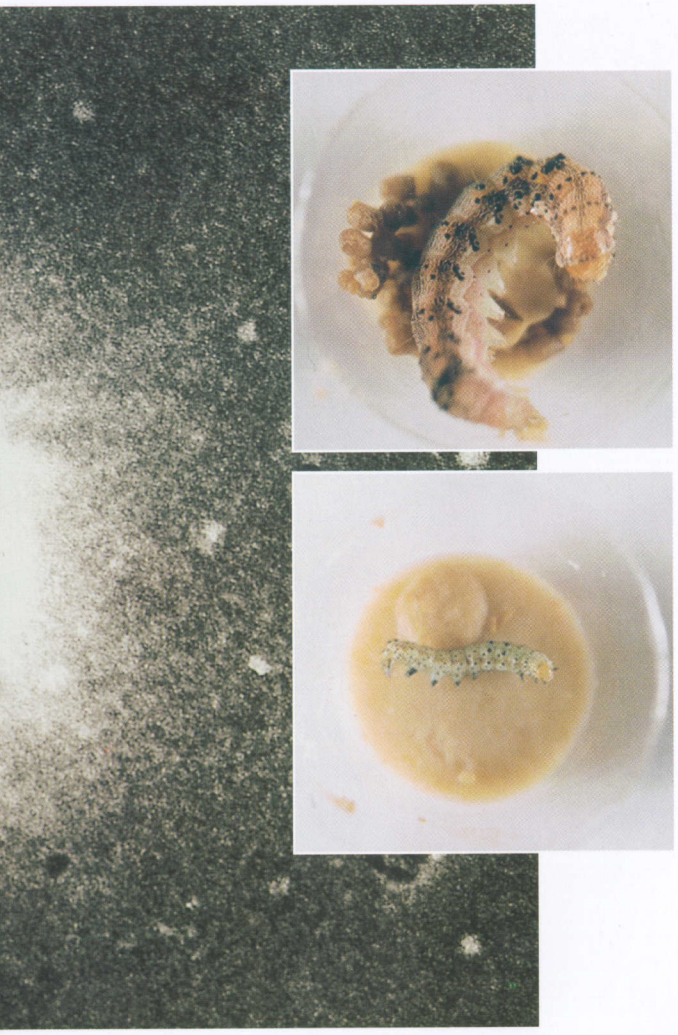
Integrated Pest Management



Agricultural productivity grew dramatically this century due to increased use of chemical pesticides and synthetic fertilizers. However, public concern in recent years has led to governmental restrictions on the release of new agrichemicals and the use of existing ones. While specific pesticides will continue to have a crucial role in maintaining production and food safety, agriculture will see increased integrated use of chemicals with biological control and improved varieties, fertilization, irrigation, and management practices.

In the early 1980s, Auburn plant pathologists began evaluating the bacteria *Bacillus subtilis* for controlling seed and seedling diseases of peanuts. Researchers developed a system of mixing this bacterium with fungicides on the seed surface to provide seedling disease control. However, bacteria continued to colonize the plant long after the fungicides had dissipated, thus protecting the tap root against invading soil fungi far into the season. This biological control agent reduced disease and allowed plants to develop greater root mass, benefits that translated into significantly greater yields. Cotton producers have been quick to accept this relatively inexpensive treatment. In 1994, almost four million acres of cotton were treated with it. Based on AAES research, the registration of this product has been expanded to cover all large-seeded legumes. Its use on tomatoes, small grains, corn, soybeans, and other crops is showing commercial potential.

Root-colonizing bacteria have been isolated from cotton fields throughout Alabama by sampling roots of healthy surviving plants in areas of seedling disease. These bacteria were screened for protection against fungal pathogens *Pythium* and *Rhizoctonia*, which cause seedling damping-off disease. Researchers found that several of these bacteria reduce cotton seedling disease levels. When used as a seed treatment, two of these bacteria were found to protect cucumber plants (which were used as an experimental model) against several pathogens. The ability to induce multiple disease resistance is unique among all plant disease management strategies. Plus, fewer cucumber beetles were found on plants treated with the bacteria. Researchers also discovered that roots and stems



AAES researchers have discovered a bacterially produced protein (left) that kills several crop pests. Its impact on the tobacco bud worm, a major cotton pest, is shown in the inset photos: the caterpillar above is a normal, healthy budworm, while the one below was fed a diet containing the insecticidal protein.

1994 Effort in Integrated Pest Management Research

Thrust area	Number of scientists	Scientist years	Funding
Development of new biocontrol agents	23	1.85	$ 674,087
Alternative pest control	29	3.10	1,057,069
Ecological effects of biocontrol	11	1.12	362,677
Physiological and molecular basis for biocontrol	11	1.11	216,940

of healthy plants are colonized internally by diverse bacteria. Some of the bacteria isolated in this project are being examined for product potential.

AAES entomologists have discovered a bacterially produced protein highly toxic to lesser cornstalk borers (a major peanut pest), as well as several caterpillars that feed on cotton and tomatoes. Studies are under way to genetically engineer peanut plants that express the gene responsible for producing the insecticidal protein. In a related investigation, researchers are working to engineer the gene into beneficial bacteria known to live on peanut and tomato plants. The genes for producing these toxic proteins were isolated from *Bacillus thuringiensis* (BT), a member of a common bacterial family that lives primarily in the soil. BT toxins are very specific; they kill the targeted pest without harming humans and other organisms.

In other pest management research, plant pathologists are developing methods of using agricultural, industrial, and urban organic wastes to improve soil fertility and replace pesticides used to sterilize soils. Many materials have been tested as soil amendments to control nematodes, soilborne fungi, and other pests. For example, studies with a mixture of chitinous crab shells, soybean meal, and urea demonstrated the possibility of preparing formulations to promote the growth of soilborne microorganisms that are harmful to plant pests. In other research, scientists showed that several inexpensive, natural volatile compounds, known as terpenes and terpenoids, have nematicidal properties at very low concentrations. Several of these compounds stimulated fungi and bacteria antagonistic to the nematodes. Researchers are pursuing the possibility of using these compounds in combination with organic waste to provide long-term suppression of plant parasitic nematodes and other soilborne pathogens.

Food Safety, Quality, Nutrition, & Health

Although the American food supply is among the safest and most economical in the world, many problems still persist. Approximately 6.5 million cases of food-borne disease occur each year, mostly caused by bacteria and other microorganisms. Chronic diseases account for five of the 10 leading causes of death in the U.S. and are now known to be related to dietary excesses or imbalances. Consumer resistance toward excessive fat, cholesterol, salt, calories, and chemical residues continues to increase. Through the AU Food Technology Institute and other units, AAES scientists are involved in a wide-ranging research program to tackle these problems

Developing new methods of controlling food-borne pathogens in meat products is a major AAES research thrust. For example, poultry scientists are investigating ways to limit colonization of *Salmonella* and other bacteria in chickens. In one study, researchers found that some lines can be selectively bred for resistance to *Salmonella*, a finding that has sparked efforts to identify commercial broiler lines that also are resistant. Researchers also observed that *Salmonella* originating from the male bird and from the breeding environment can persist in the hen oviduct and ultimately contaminate hatching eggs. This contamination would then be a source of the pathogen in newly hatched chickens destined for production of broiler meat. These findings verify that breeding is a critical point at which food safety intervention steps can be effectively applied. Another approach to controlling *Salmonella* during live production is the concept of "competitive exclusion," in which orally administered beneficial bacteria prevent the pathogens from colonizing the gastrointestinal tracts of chickens. A number of bacteria, which are commercially available and easily applied under existing commercial production practices, have been characterized. These bacteria can reduce the spread of *Salmonella* that typically occurs when birds are stressed.

Animal health researchers have tested several compounds to control the protozoan parasite that causes toxoplasmosis, a disease that can be deadly to congenitally infected infants, young children, and adults with compromised immune systems. Toxoplasmosis can be acquired by eating raw or under-cooked pork or other meats that contain the infective tissue cyst stage of the protozoa *Toxoplasm gondii*. When treated with an experimental vaccine, pigs did not develop toxoplasmosis when challenged

Food quality and safety research sponsored by the AAES benefits the food industry throughout Alabama.

with virulent stages of the parasite, and meat from the pigs contained fewer infective cysts. Researchers also identified a drug that is highly effective in preventing toxoplasmosis in pigs. The drug can be used at low concentrations in feed and will not cause adverse reactions.

Convenient and accurate methods for detecting the presence of bacteria in processed, farm-raised catfish products are necessary to assure their safety and quality for consumers. AAES fisheries researchers developed a rinse technique for sampling catfish products in the processing plant to determine the amount of surface bacteria they contain. The technique is nondestructive, time and labor efficient, and as effective as the conventional sample grinding procedure. This procedure is currently being used at the Fish Farming Center in Greensboro, Ala., to monitor bacterial quality of catfish from commercial processing plants.

While most consumers are concerned about harmful synthetic chemical residues in food products, few are aware that one of the most toxic substances known to man is produced by naturally occurring fungi. This carcinogenic substance, known as aflatoxin, is produced by the fungus *Aspergillus flavus*, which is widespread and difficult to control. Once these fungi have invaded plant tissue, such as peanut seed, they can produce aflatoxins. Minimizing aflatoxin contamination is critical in order to continue to provide a safe food supply. AAES plant pathologists and entomologists discovered that larvae of the lesser cornstalk borer, a major pest in peanuts, can carry these fungi into developing peanut seed. Research indicates that control of the lesser cornstalk borer reduces fungal invasion of peanut seed during crop growth, which subsequently reduces aflatoxin contamination in harvested peanuts. In other studies, researchers identified bacteria that improve peanut plant stands, while protecting developing pods from invasion by aflatoxigenic fungi.

1994 Effort in Food Safety, Quality, Nutrition, and Health Research

Thrust area	Number of scientists	Scientist years	Funding
Nutritional quality and human health	14	2.85	$689,564
Post-harvest technologies	7	0.81	298,544
Novel products important to Alabama	5	0.21	78,963
Food-borne pathogens and toxins	9	0.77	266,374
Diet-related health status of Alabamians	3	0.69	121,557
Food-borne disease surveillance	1	0.02	1,743

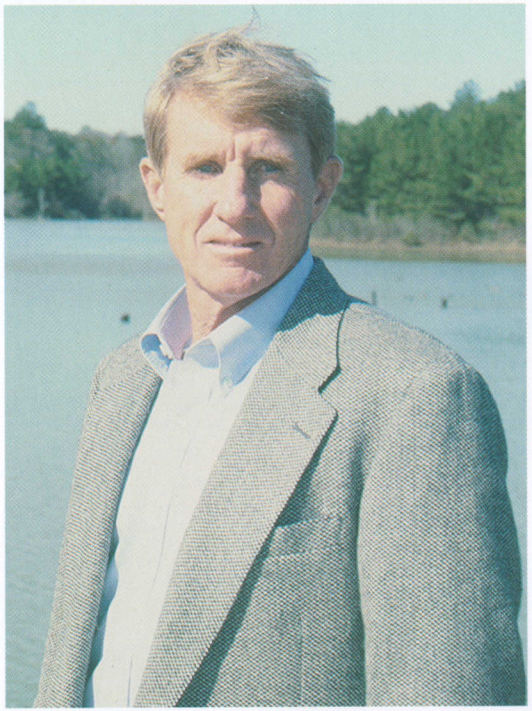
AAES researchers also are working to develop products that meet consumer demands for leaner meat. In one such project, animal scientists found that hormonal treatments may help produce leaner, more muscular pigs. Researchers discovered that performance and carcass composition benefits can be gained when the growth hormone porcine somatotropin (pST) is administered to pregnant gilts. In addition to improving efficiency of the pigs, this management strategy also enhanced productivity of the sows. This project was the first use of pST in a management scheme for early-gestating gilts. If approved by the Food and Drug Administration, the use of pST in swine production should benefit consumers, producers, and packers.

Nutritional quality and human health are the focus of other AAES research programs. In one study, food scientists compared trained, competitive cyclists to a non-active control group in an effort to determine whether a normal diet can support optimal health despite high concentrations of exercise and energy expenditure. Preliminary results showed that the cyclists consumed about 50 percent more vitamin C than the non-active group, but they had almost identical blood and urine levels of vitamin C. This finding could indicate a greater need for vitamin C in highly active people. Another test indicated that exercise and high-carbohydrate diets increase the need for thiamin.

Each year in Alabama two to three infants are born with the rare genetic disorder phenylketonuria (PKU), a lifetime condition in which the ability of the body to break down phenylalanine, an amino acid in protein, is impaired. If not treated, PKU results in severe mental retardation, but if diagnosed early and treated with a special diet, there are no harmful effects. Medical foods, which are designed to limit protein intake, provide these children with the majority of their daily needs for protein, vitamins, and minerals. One nutritional study investigated the effects of medical foods or related diets on several aspects of nutrition and health status. Results documented lower concentrations of antibodies, which help destroy foreign substances in the body, in children with PKU. Further research is needed to determine whether this problem is related to the medical diets. Intake of two essential minerals, selenium and molybdenum, was found to be less than two-thirds of the Estimated Safe and Adequate Daily Dietary Intake for children with PKU. Iron intake by children with PKU was two to three times higher than recommendations. Yet, iron deficiency without anemia was found in about a third of the children. The impact of these findings may lead to reformulation of the medical foods and ultimately improve the health of infants and children with PKU.

1994 Director's Research Awards

Winners of the 1994 Alabama Agricultural Experiment Station Director's Research Awards were Tom Lovell, a professor of fisheries and allied aquacultures in the College of Agriculture; and Greg Pettit, an associate professor of family and child development in the School of Human Sciences. The awards, which were initiated in 1981, are given annually to recognize outstanding career accomplishments within the AAES.

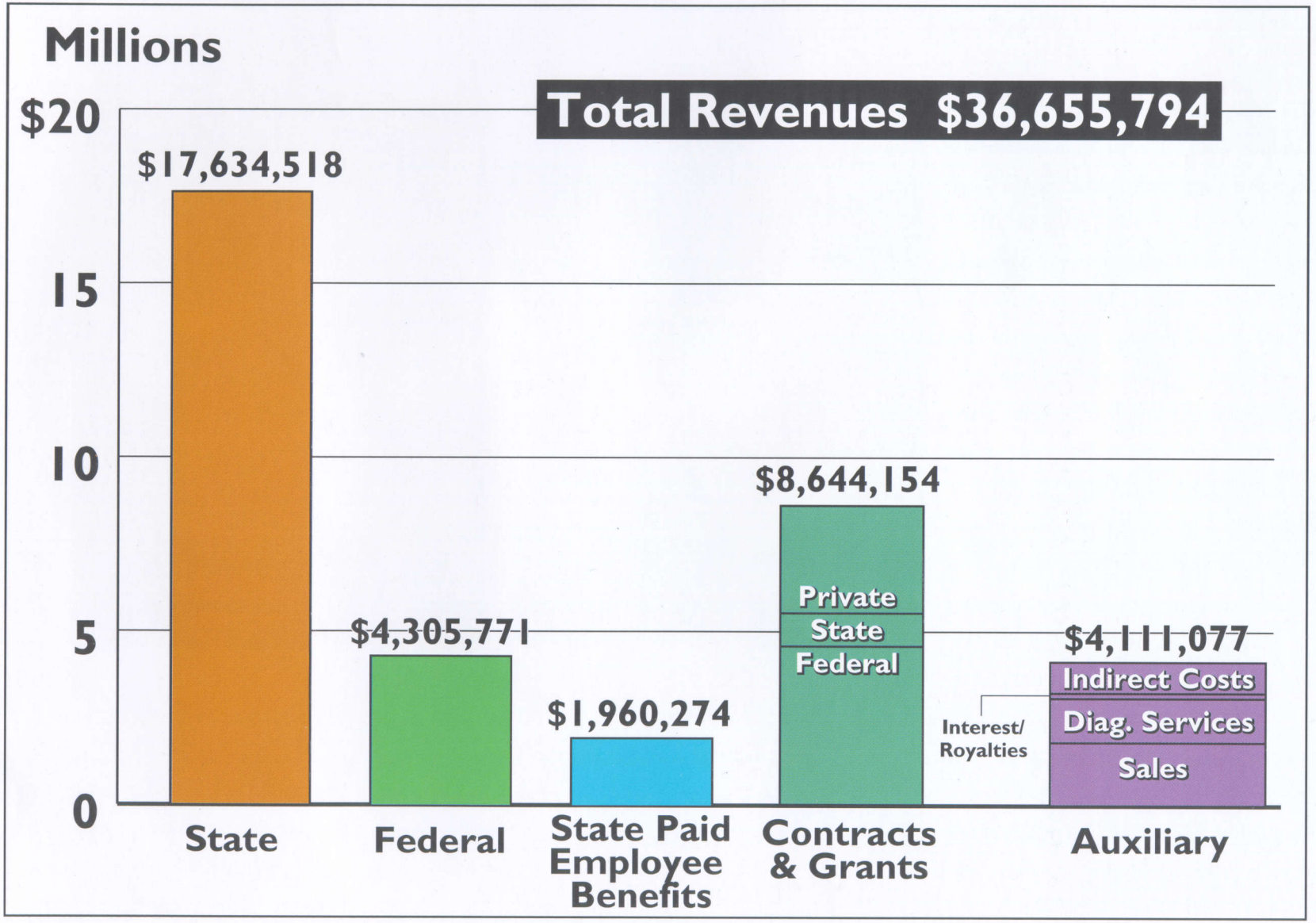


Senior Research Award winner, Dr. Tom Lovell

Junior Research Award winner, Dr. Greg Pettit

Lovell, who came to Auburn in 1969, is among the world's top scientists in the study of nutrition of warm water fish. He played a significant role in the growth of Alabama's catfish industry with his efforts to develop low-cost, highly productive feeds. His documentation of the fish's inability to synthesize Vitamin C led to a greater understanding of several fish diseases. Lovell also has won international acclaim for identifying the source and cause of off-flavor in intensively cultured fish and shrimp. In addition, Lovell has been a leader in the development of Auburn's international fisheries program, having worked in or visited 26 countries.

Pettit, who joined the Auburn faculty in 1989, studies the way children enter and sustain relationships with their peers. Peer rejection in early childhood is a primary risk factor for psychological maladjustment later in life. By finding ways for young children to become socially adjusted, many later problems can be avoided. Initial findings suggest that parents play a vital role in the development of a child's social skills. Much of that influence comes from children copying their parent's actions. Another leading factor is how parents coach their children when the youngsters are interacting with peers. Pettit has been awarded nearly $2 million in extramural grants from the National Institutes of Health.


Millions
$20
15
10
5
0
Total Revenues $36,655,794
$17,634,518
$4,305,771
$1,960,274
$8,644,154
Private
State
Federal
Interest/
Royalties
$4,111,077
Indirect Costs
Diag. Services
Sales
State
Federal
State Paid Employee Benefits
Contracts & Grants
Auxiliary